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(71) Applicant(s)

Fujitsu Limited

(Incorporated in Japan)

1-1 Kamikodanaka 4-chome, Nakahara-ku,
Kawasaki-shi, Kanagawa 211, Japan

(72) Inventor(s)

Kimio Watanabe

(74) Agent and/or Address for Service

Haseltine Lake & Co

Hazlitt House, 28 Southampton Buildings, Chancery
Lane, LONDON, WC2A 1AT, United Kingdom

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H04L 12/407

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WO 87/02155 A1 US 5005122 A

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UK CL (Edition O) G4A AFGK , H4P PPBB PPBC PPD
PQA

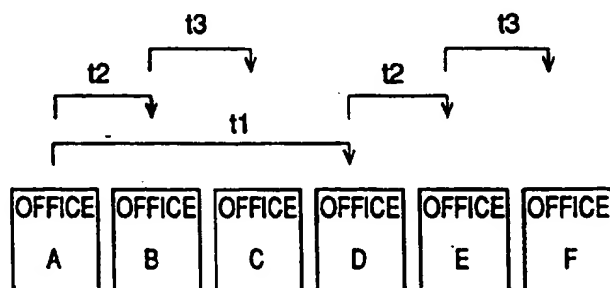
INT CL⁶ H04L 12/407 12/42 12/44 , H04Q 3/00

Online:WPI

(54) Software distribution network

(57) A method of transferring information to a plurality of offices B to F connected in series in a network includes the following steps. A step (a) is transferring the information from a server office A to an intermediate office D being substantially intermediate in the plurality of offices. A step (b) is setting the intermediate office D which received the information in the step (a) to the server office. A step (c) is virtually dividing the plurality of offices into two groups A to C, D to F which respectively include the server offices A, D. And, a step (d) is repeating the steps (a) to (c) for each of the two groups. This is for software distribution.

FIG . 7



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FIG . 1
PRIOR ART

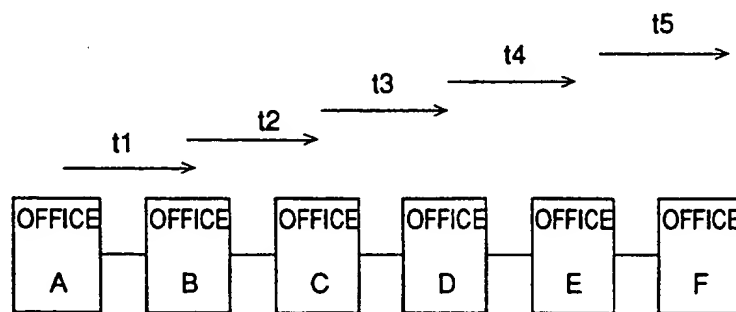
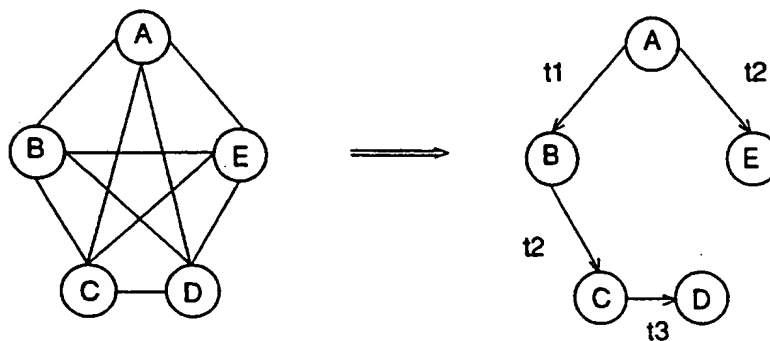
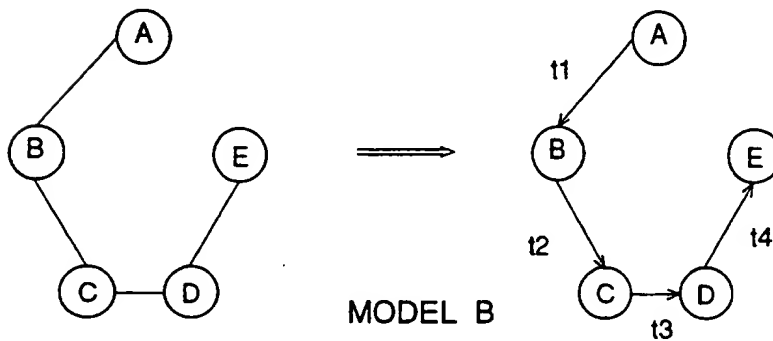


FIG . 2
PRIOR ART



MODEL A



MODEL B

FIG. 3

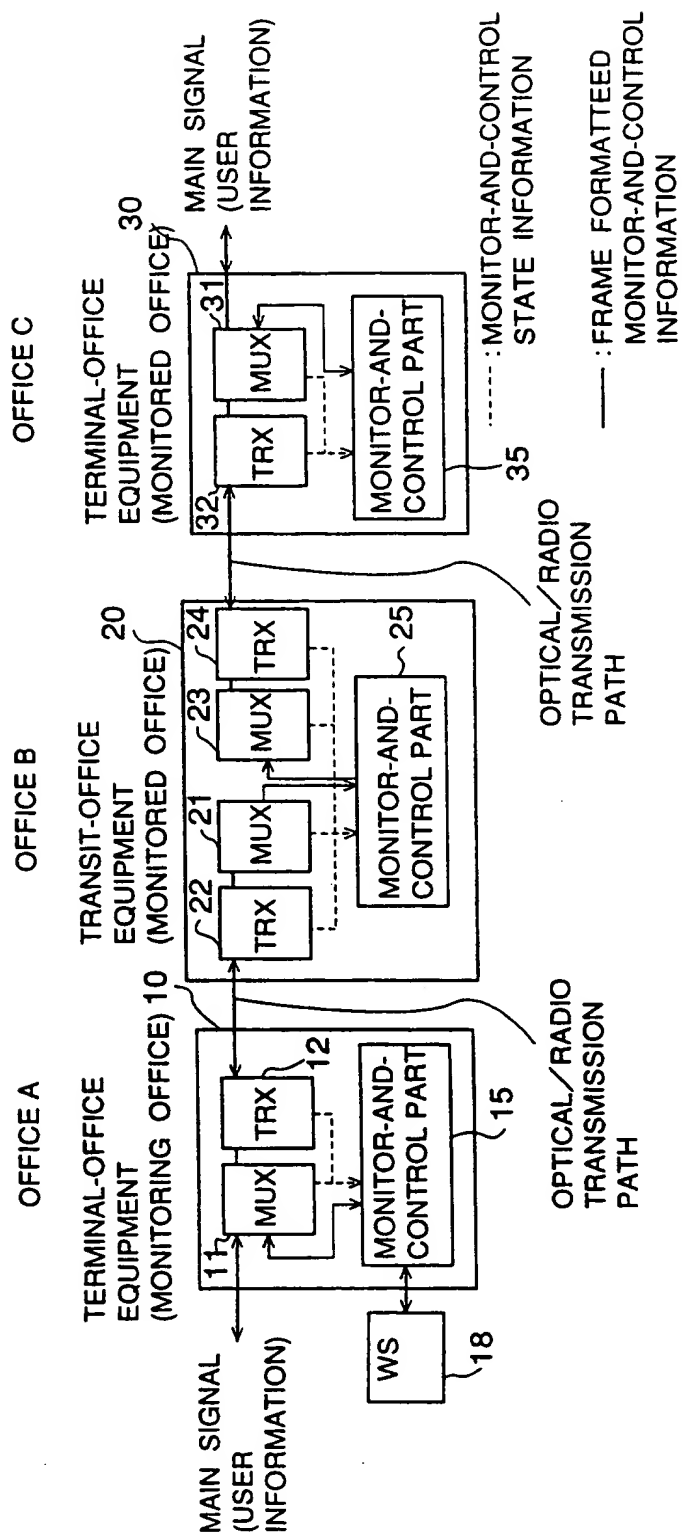


FIG . 4

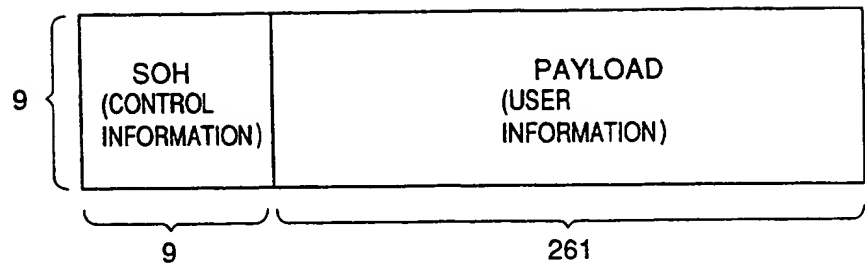


FIG . 5



FLAG : 01111110 (8 bit)
 ADDRESS : COMMUNICATION APPARATUS ID INFORMATION (8 bit)
 CONTROL : TRANSMISSION-ORDER CONTROL, etc, INFORMATION (8 bit)
 INFORMATION : MONITOR-AND-CONTROL INFORMATION (8 bit x n) n: INTEGER
 (DOWNLOAD INFORMATION)
 FCS : ERROR DETECTION (16 bit)

FIG.6

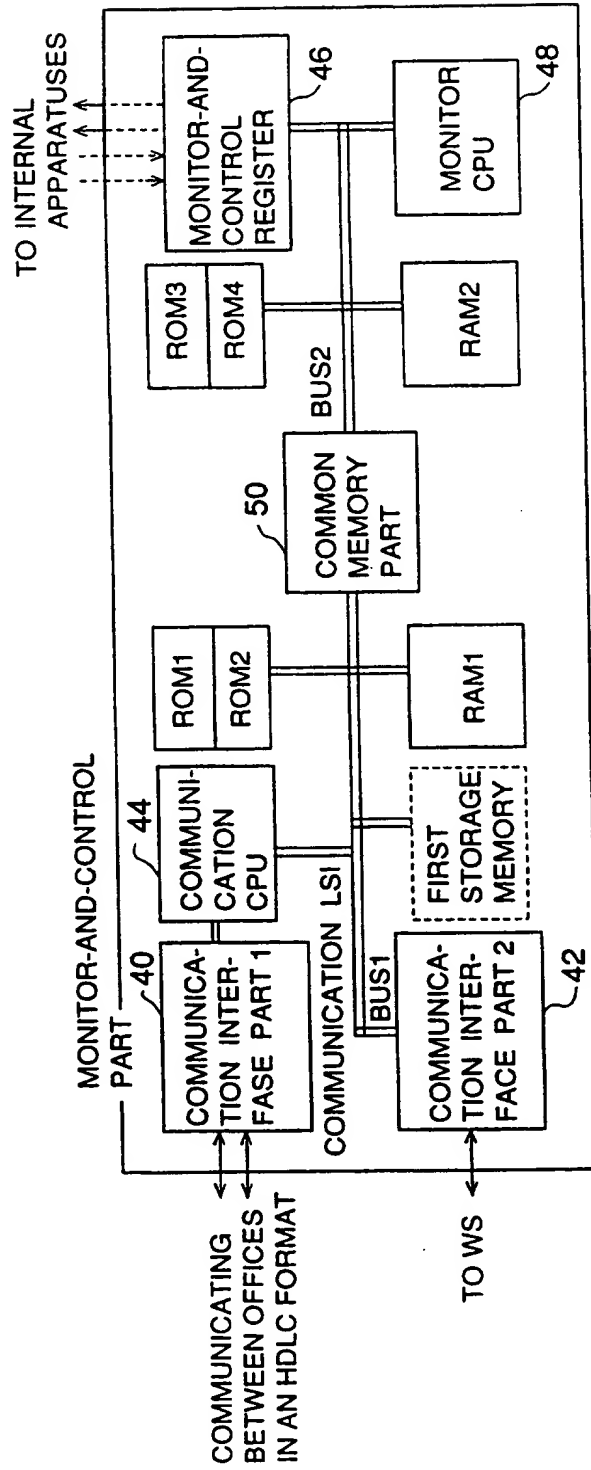


FIG. 7

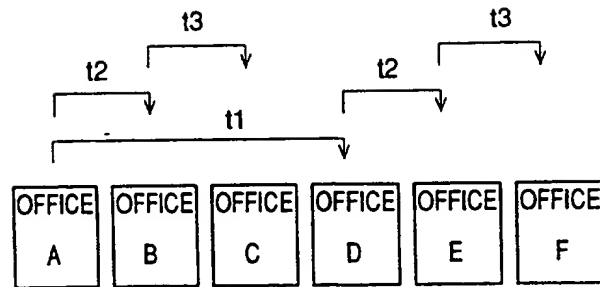


FIG. 8A

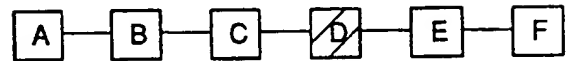


FIG. 8B

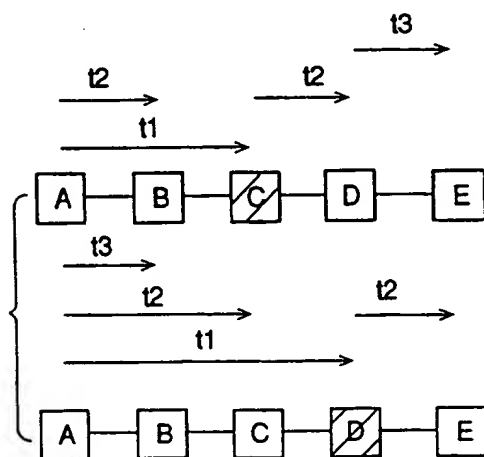


FIG . 9A

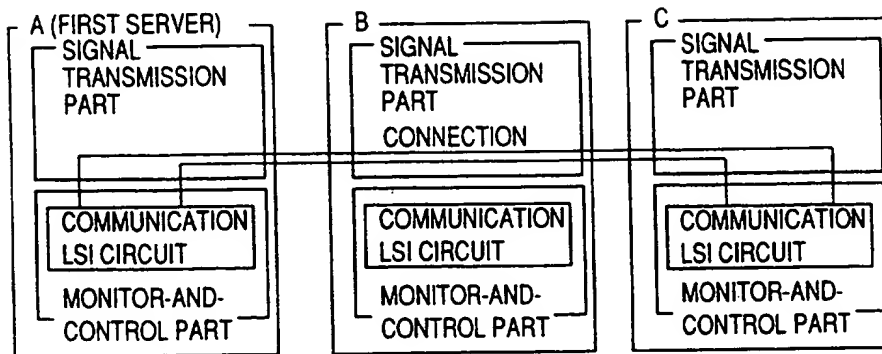
(CONFIGURATION OF
A CONNECTION)

FIG . 9B

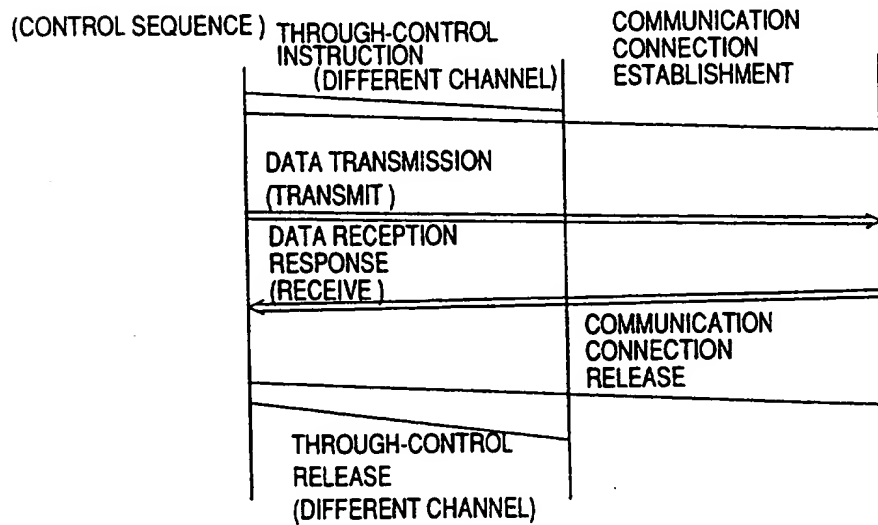


FIG . 9C

(CONFIGURATION OF
A CONNECTION)

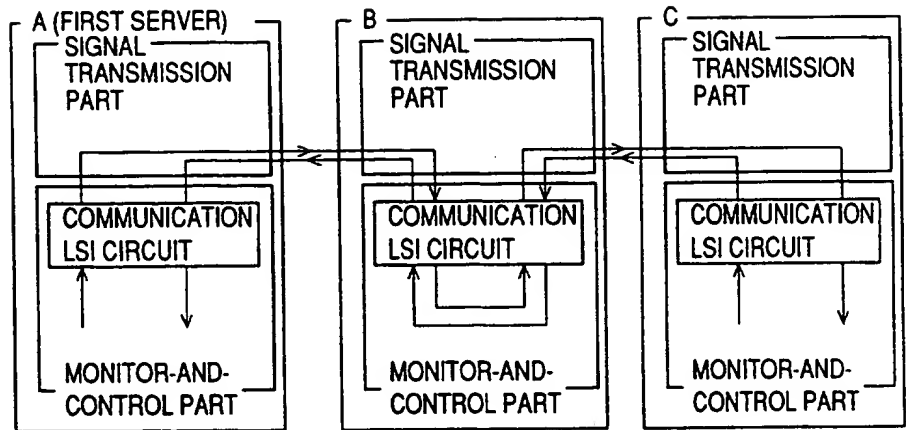


FIG . 9D

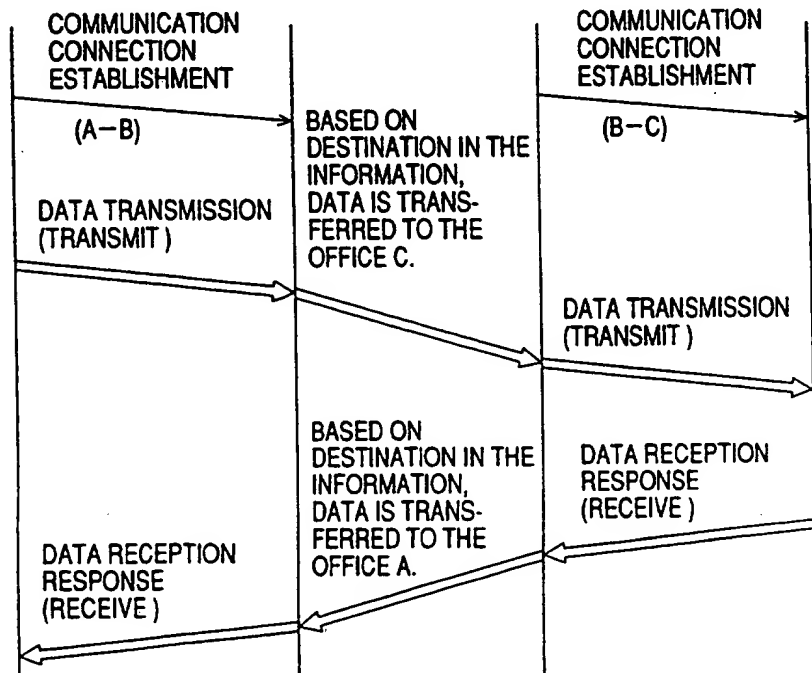


FIG.10

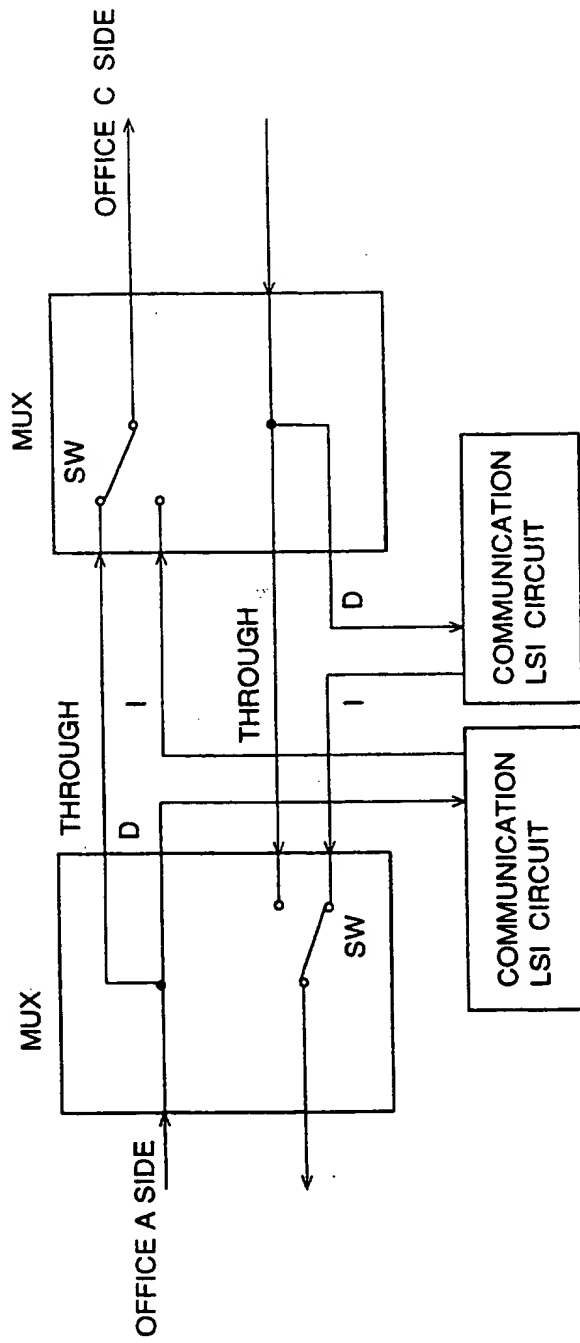
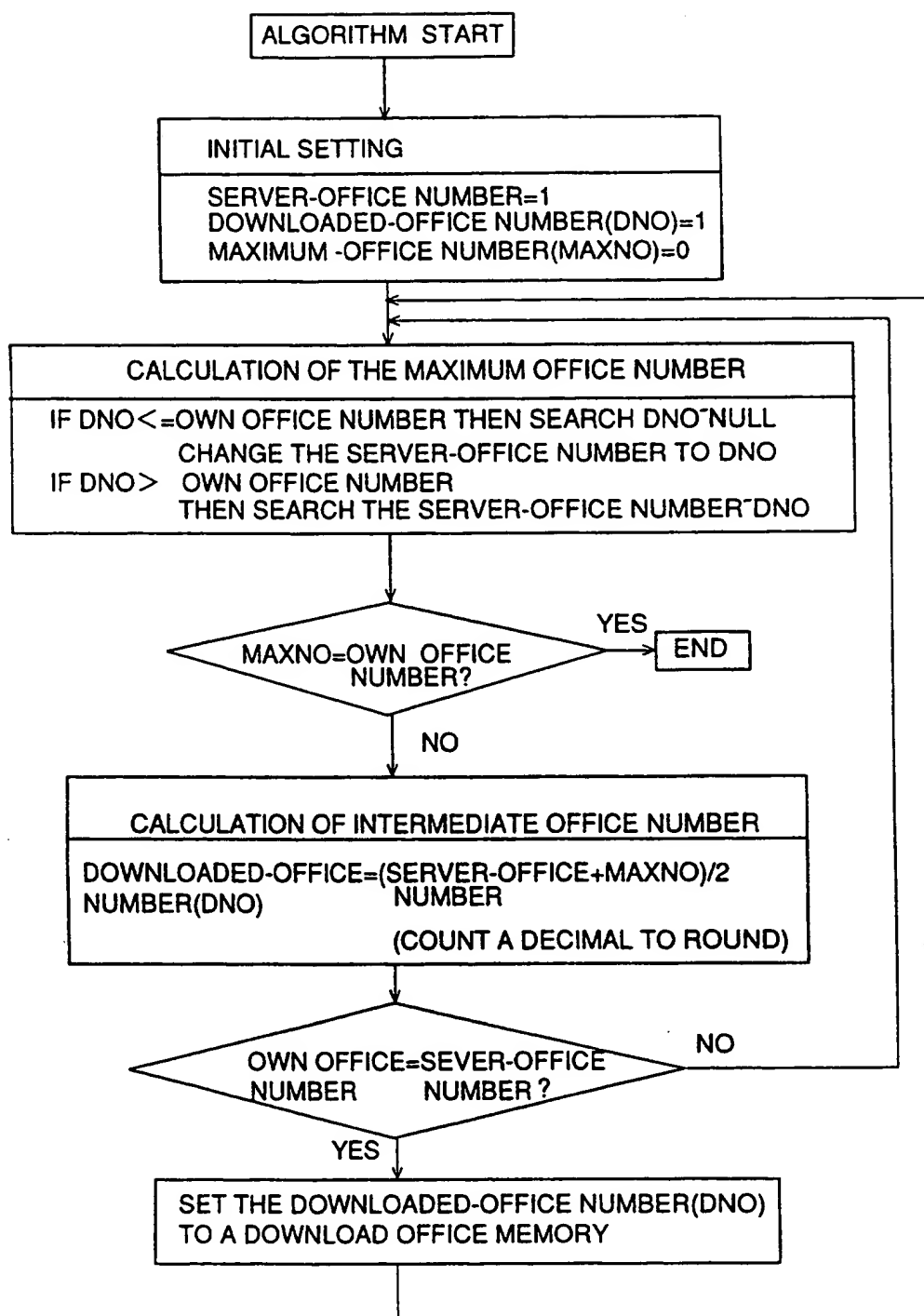


FIG . 11

ADDRESS

1	2	3	4	5	6	7
OFFICE A	OFFICE B	OFFICE C	OFFICE D	OFFICE E	OFFICE F	NULL

FIG . 12



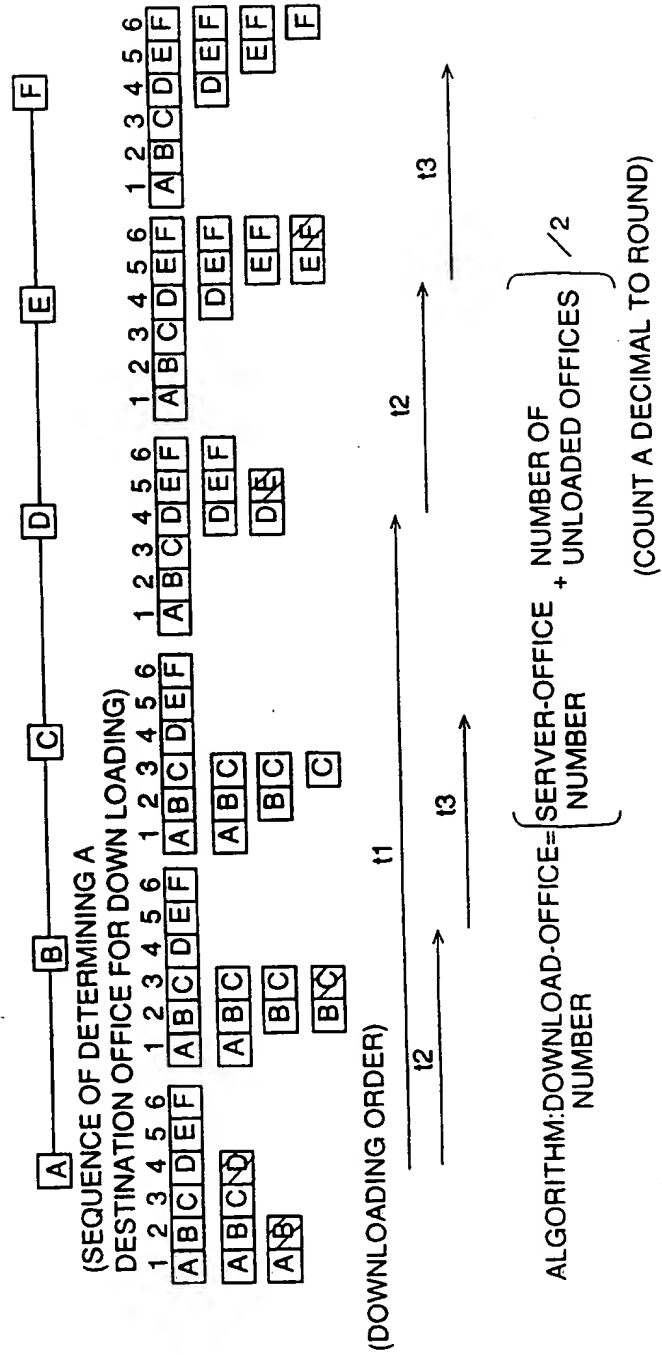


FIG . 14

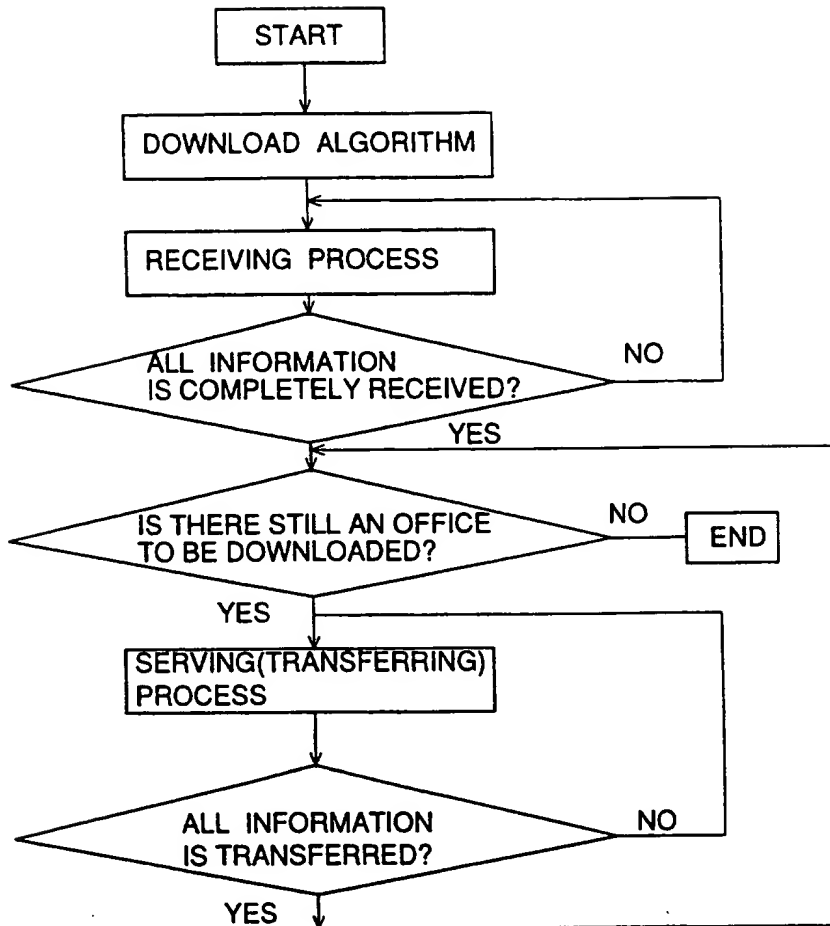


FIG.15

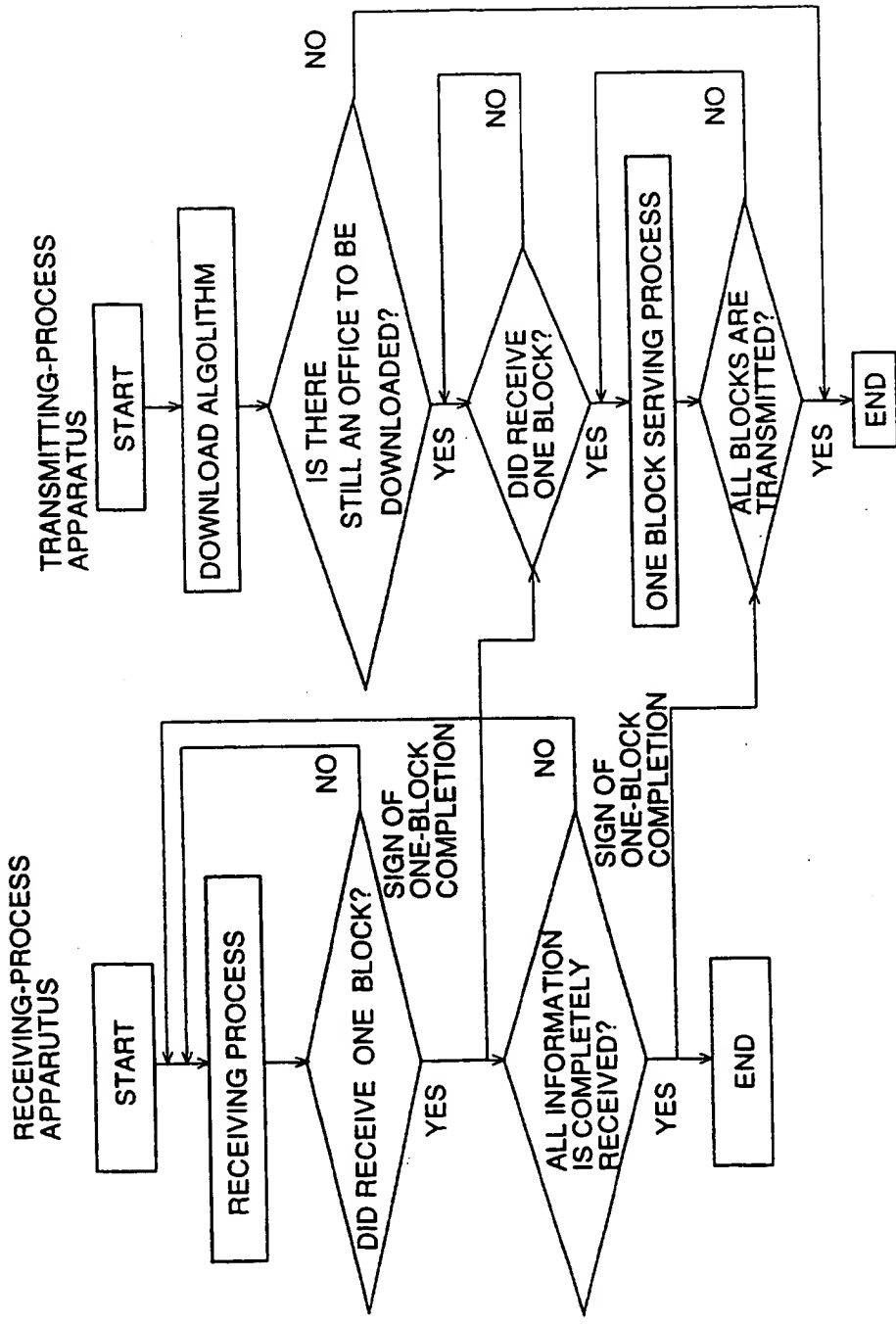


FIG.16

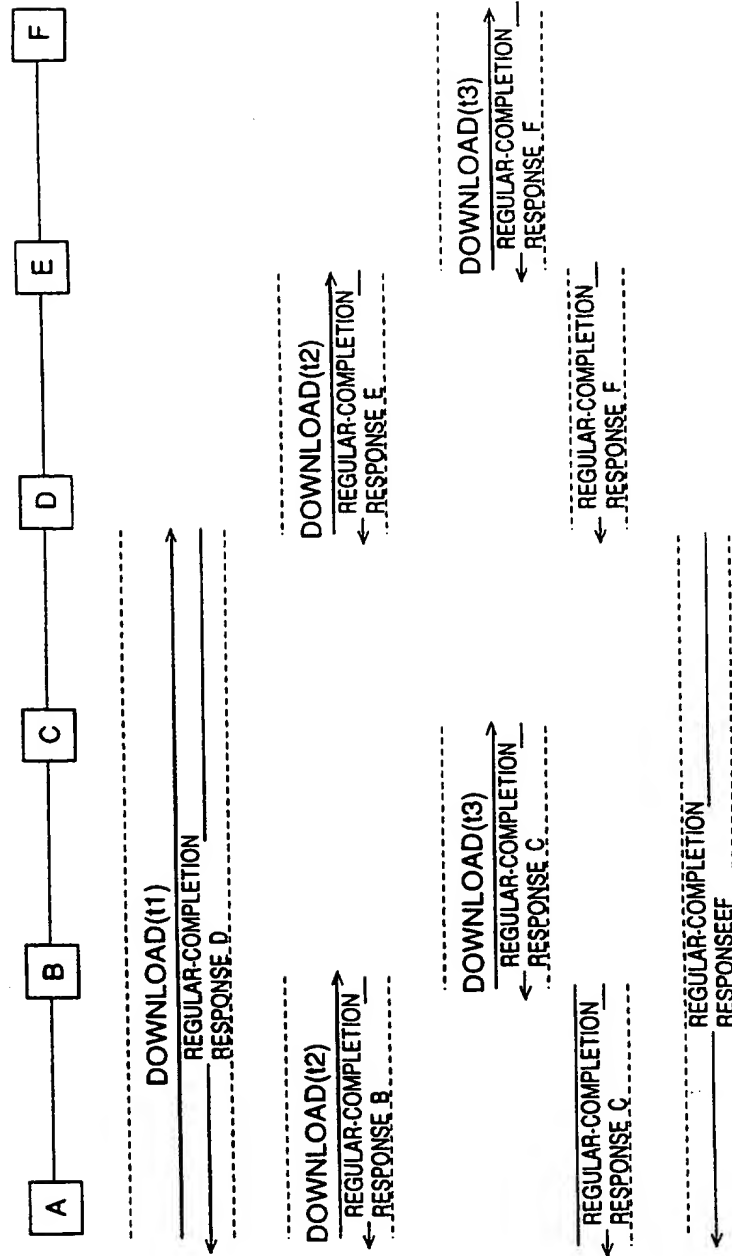


FIG . 17

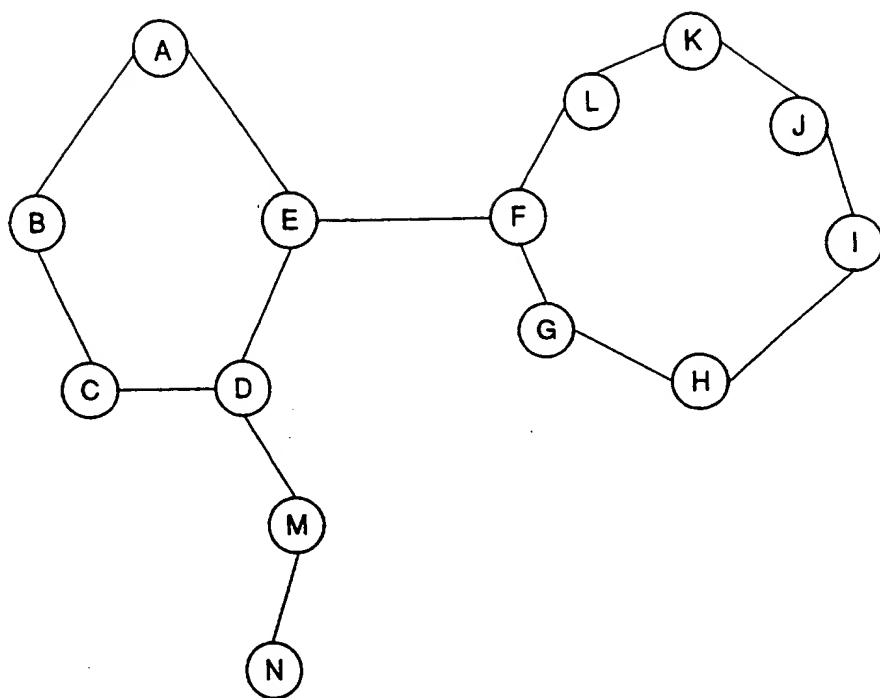


FIG.18B

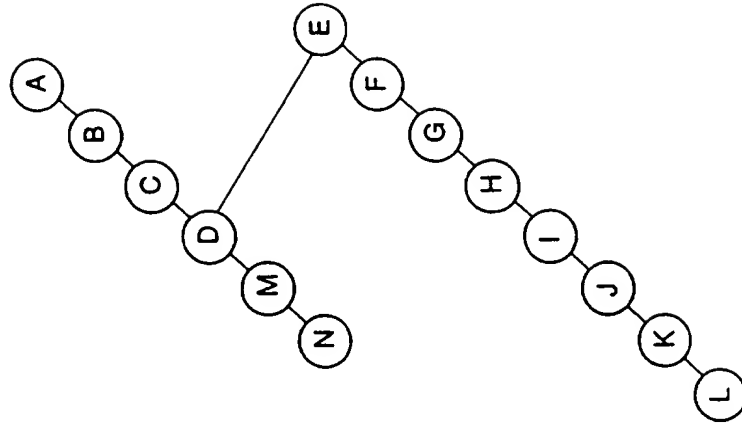
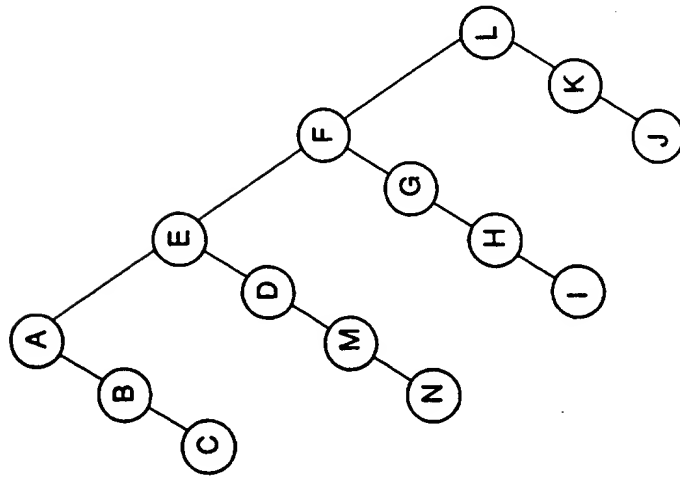


FIG.18A



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METHOD AND APPARATUS
FOR TRANSFERRING INFORMATION

5 The present invention generally relates to a method and apparatus for transferring information, and more particularly, to a method and apparatus for transferring information which will efficiently download the same information, for example, software, to a plurality of offices constructing a network.

10 The present invention is also directed to a method and apparatus for transferring information which downloads special information to a given office.

15 A telecommunication network becomes complex in order to provide a variety of services. Therefore, it becomes important to manage such a network. Network management is currently developed also in international standardization. For example, in the international telecommunication union (ITU-T), standardization of an operation of a telecommunication
20 carrier and a telecommunication management network (TMN) for network management is carried out. Also, supervision and control of the telecommunication is standardized.

25 For such network management, respective transmission equipment in offices constructing the network has a managing function, and the transmission equipment in the offices is managed by a given operation center. In general, each office's managing function is constructed with software. When the
30 network is initially constructed, or when the managing function is added and changed, it is necessary to install new software of the managing function to the transmission equipment of the respective offices.

35 In the prior art, for changing the software of the transmission equipment in a remote office, a maintenance man changes a ROM of the equipment in the remote office. However, for developing the above-

1 mentioned management network, a software download
technique, namely a technique loading or updating the
software of the remote office by using a communication
line, is now indispensable.

5 At present, several download methods for a
network managing system are known. In a typical
method, a server office sequentially downloads the
software to a plurality of offices on the network in a
relay transmission form. FIG. 1 shows an illustration
10 for explaining that prior-art downloading method.
FIG. 1 shows a linear-structure network model in which
offices A to F are connected in series. In the prior-
art downloading method, the office A downloads the
information to respective offices, or the office A
15 initially downloads to the adjacent office B, next,
the office B downloads to the adjacent office C, and
at last, the office E downloads to the office F.

However, in the above-mentioned prior-art
method, there is the following problem. A download
20 time increases in proportion to a number of offices in
the network. For example, when the download time for
one office is 10 minutes, it takes 1000 minutes for
downloading of 100 offices. This method is
represented by an $O(n)$ method in which a total
25 download time for n offices is n times the download
time for one office.

In an ideal downloading method, it is known
that the total download time for n offices is
approximately $\log_2 n$ times the download time for one
30 office. For example, when the download time for one
office is 10 minutes, it takes approximately 70 ($10 \times$
 $\log_2 100$) minutes for downloading of 100 offices. This
method is represented by an $O(\log_2 n)$ method.

For realizing the ideal downloading method,
35 another method is proposed in a reference "SEMF
software architecture for SDH transmission equipment",
Japanese technical report of the Institute of

1 Electronics, Information and Communication engineers
(IEICE), IN93-41 (1993-08), pp.41-46. In this method,
the download of the $O(\log_2 n)$ method may be carried out
only in a limited network model.

5 FIG. 2 shows an illustration for explaining
the prior-art downloading method disclosed in the
above-mentioned reference. There are two models, a
model A indicates a network model in which all offices
are connected with each other by lines, and a model B
10 indicates a network model in which all offices are
connected in series (linear structure) by the lines.
In this method, when the software is downloaded to any
office, this office operates as a server, and
downloads to an adjacent office. The download is
15 carried out in an undefined order. Therefore, this
method is applicable to the model A, but is not
applicable to the model B.

When the method disclosed in the above-
mentioned reference is applied to the model A, the
20 software can be downloaded to all offices by 3-
downloading operations. For example, after the
downloading operation from the office A to the office
B is carried out (t_1), the downloading operation from
the office A to the office E and the downloading
25 operation from the office B to the office C can
simultaneously be carried out (t_2). Therefore, the
download may be performed by the $O(\log_2 n)$ method.

However, to the model B in FIG. 2, the
method in the above-mentioned reference can not be
30 applied. In the model B, after the downloading
operation from the office A to the office B is carried
out (t_1), the downloading operation from the office A
to the office E and the downloading operation from the
office B to the office C cannot simultaneously be
35 carried out because of traffic overlapping in network
lines. Therefore, for downloading of all offices, 4-
downloading operations are required. In the model B,

1 the download cannot be performed by the $O(\log_2 n)$
method.

As discussed above, the prior-art
downloading method in the above-mentioned reference is
5 applicable to only a case where all offices are
connected with each other by the lines, and a case
where a network model is identical to a model
supporting the $O(\log_2 n)$ method. Therefore, in the
prior-art downloading method, there is a problem in
10 that the download time increases. When the download
time increases, the time for the maintenance man
waiting for the downloading also increases, and, thus,
network-management efficiency is degraded.

It is an object of the present invention to
15 provide an information transferring method and
apparatus for efficiently downloading information data
to a plurality of offices in any network architecture,
in which the disadvantages described above are
eliminated.

20 According to one aspect of the present
invention, there is provided a method of transferring
information to a plurality of offices connected in
series in a network, the method comprising the steps
of: (a) transferring the information from a server
25 office to an intermediate office being substantially
intermediate in the plurality of offices; (b) setting
the intermediate office which received the information
in the step (a) to the server office; (c) virtually
dividing the plurality of offices into two groups
30 which respectively include the server offices; and (d)
repeating the steps (a) to (c) for each of the two
groups.

According to another aspect of the present
invention, there is provided an apparatus for
35 transferring information from a server office to a
plurality of offices connected in series in a network,
the apparatus comprising: a receiving circuit for

1 receiving the information; a transferring circuit for
transferring the information to an intermediate office
being substantially intermediate in the plurality of
offices.

5 In the above method and apparatus, the
server office transfers the information to the
intermediate office being substantially intermediate
in the plurality of offices connected in series. In
this case, a total download time for n offices is
10 positively given by approximately $\log_2 n$ times a
download time for one office. Therefore, the total
download time may be extremely reduced as compared to
a prior-art method taking n times the download time
for one office.

15 According to another aspect of the present
invention, there is provided the method mentioned
above, wherein the method further comprises a step of
previously storing in a memory which office in the
plurality of offices is the intermediate office.

20 According to another aspect of the present
invention, there is provided the apparatus mentioned
above, wherein the apparatus further comprises a
memory storing which office in the plurality offices
is the intermediate office.

25 In the above method and apparatus, the
information for the intermediate office is previously
stored in the memory. Therefore, the downloading
method and apparatus according to the present
invention may easily be constructed.

30 According to another aspect of the present
invention, there is provided the method mentioned
above, wherein the step (a) further comprises a step
of calculating which office in the plurality of
offices is the intermediate office based on a network
35 architecture.

According to another aspect of the present
invention, there is provided the apparatus mentioned

1 above, wherein the apparatus further comprises a
calculating circuit for determining which office in
the plurality offices is the intermediate office based
on a network architecture.

5 In the above method and apparatus, which
office in the plurality of offices is the intermediate
office is calculated based on the network
architecture. Therefore, even when the network
architecture is changed, a downloading operation may
10 easily be carried out only by transferring information
of the network architecture to each office.

 According to another aspect of the present
invention, there is provided the method mentioned
above, wherein the method further comprises a step of
15 dividing the information into a plurality of blocks,
and every time one block of the blocks is received in
each office, transmitting the one block to a next
office.

 According to another aspect of the present
20 invention, there is provided the apparatus mentioned
above, wherein the apparatus further comprises a
parallel-process control circuit for dividing the
information into a plurality of blocks, and
transmitting one block of the blocks to a next office
25 every time the one block is received.

 In the above method and apparatus, the
information is divided into the plurality of blocks.
In each office, every time the one block is received,
the one block is transferred to the next office.
30 Namely, for each block, transmission and reception are
carried out in parallel. Therefore, the total
download time may be further reduced.

 According to another aspect of the present
invention, there is provided the method mentioned
35 above, wherein the method further comprises the steps
of: returning a response indicating a regular
completion of receiving the information from a first

1 office which received the information to a second
office which transferred the information to the first
office; and receiving a plurality of the responses in
a third office from other offices following the third
5 office, and returning the plurality of responses from
the third office to a fourth office which previously
transferred the information to the third office.

According to another aspect of the present
invention, there is provided the apparatus mentioned
10 above, wherein the apparatus further comprises: a
first responding circuit for returning a response
indicating a regular completion of receiving the
information to an office which transferred the
information to the apparatus; and a second responding
15 circuit for receiving a plurality of the responses
from other offices and for returning the plurality of
responses to an office which previously transferred
the information to the apparatus.

In the above method and apparatus, when the
20 information is received, the response of the regular
completion is returned to the server office of the
information. And, when the plurality of responses
from other offices are received, the plurality of
responses are transferred to an upper-level server
25 office. Therefore, without degrading efficiency of
the downloading operation, the response of the regular
completion may be returned.

According to another aspect of the present
invention, there is provided the method mentioned
30 above, wherein the step (a) comprises a step of
downloading software to the intermediate office.

According to another aspect of the present
invention, there is provided the apparatus mentioned
above, wherein the transferring circuit comprises a
35 circuit for downloading software to the intermediate
office.

In the above method and apparatus, setup and

1 update operations of a monitor-and-control apparatus
may easily be carried out.

Other objects and further features of the
present invention will be apparent from the following
5 detailed description when read in conjunction with the
accompanying drawings.

FIG. 1 shows an illustration for explaining
a prior-art downloading method;

FIG. 2 shows an illustration for explaining
10 another prior-art downloading method;

FIG. 3 shows a block diagram of a
configuration example of a monitor-and-control system;

FIG. 4 shows an example of a format of a
multiplexed signal passing through a transmission path
15 between offices;

FIG. 5 shows an example of a frame format of
monitor-and-control information;

FIG. 6 shows a block diagram of a
configuration example of a monitor-and-control part;

FIG. 7 shows an illustration for explaining
20 an operation of a first embodiment of a downloading
method according to the present invention;

FIG. 8A and FIG. 8B show illustrations for
explaining a downloading order of the downloading
25 method according to the present invention;

FIG. 9A and FIG. 9B show a method of
establishing a connection in the downloading method
according to the present invention. FIG. 9A shows a
configuration of the connection, and FIG. 9B shows a
30 control sequence;

FIG. 9C and FIG. 9D show another method of
establishing the connection in the downloading method
according to the present invention. FIG. 9C shows a
configuration of the connection, and FIG. 9D shows a
35 control sequence;

FIG. 10 shows a detail configuration of a
through line in transit-office equipment shown in FIG.

1 3;

FIG. 11 shows a memory configuration storing topology information of the network shown in FIG. 7;

5 algorithm which is provided in each office;

FIG. 13 shows an illustration for explaining a downloading operation of a recursive-processing-type downloading method based on the algorithm shown in FIG. 12;

10 FIG. 14 shows a flowchart of the downloading operation in each office;

FIG. 15 shows a flowchart of a transmitting-and-receiving parallel process in a third embodiment of the downloading method according to the present invention;

FIG. 16 shows an illustration of explaining a responding method in the downloading method according to the present invention;

20 FIG. 17 shows a configuration example of a typical main transmission network; and

FIG. 18A and FIG. 18B show examples of a method of virtually analyzing the complex network shown in FIG. 17.

25 First, a description will be given of a configuration of a downloading apparatus before a description of embodiments of the downloading method according to the present invention.

FIG. 3 shows a block diagram of a configuration example of a monitor-and-control system. In FIG. 3, a network constructed with three offices A, B and C is shown. The three offices are connected in series (linear structure) through optical transmission paths or radio transmission paths.

35 In the network, information from a plurality of users connected to the office A is multiplexed in the office A, and multiplexed information is transmitted to the office C through the office B. In

1 the office C, the multiplexed information is
demultiplexed, and demultiplexed information is
transmitted to a plurality of users connected to the
office C. In the opposite way, the users belonging to
5 the office C can also transmit the information to the
users belonging to the office A. Further, the users
belonging to the offices A, C can communicate with
users belonging to the office B. For a multiplexing
method, time-division multiplexing, frequency-division
10 multiplexing, code-division multiplexing, etc., are
usable.

The office A and the office C respectively
have terminal-office equipment 10 and terminal-office
equipment 30, and the office B has transit-office
15 equipment 20. The terminal-office equipment 10, 30
respectively include multiplex/demultiplex parts
(MUXs) 11, 31 for multiplexing the user information
and demultiplexing a multiplexed signal, and further
respectively include signal-transmission parts (TRXs)
20 12, 32 for transmitting and receiving the multiplexed
signal. The transit-office equipment 20 in the office
B includes a signal-transmission part 22 and a
multiplex/demultiplex part 21 for communicating with
the office A, and further includes a signal-
25 transmission part 24 and a multiplex/demultiplex part
23 for communicating with the office B.

The equipment 10, 20, 30 in the offices A,
B, C further respectively includes monitor-and-control
parts 15, 25, 35 for monitoring communication
30 apparatuses such as a signal transmission part and a
multiplex/demultiplex part. Each monitor-and-control
part detects an operation condition and any trouble in
the communication apparatuses and any trouble in
communication lines. Detected information is
35 processed as monitor-and-control information. The
monitor-and-control information is converted to serial
information, and is transmitted to an upper-level

1 office through the communication lines.

In the example shown in FIG. 3, the monitor-and-control information generated in the offices B, C is transmitted to the office A. In this way, the communication apparatuses in the office B and the office C are monitored by the office A. In a practical operation, the three offices including the office A are monitored and controlled by a work station 18 provided in the office A.

10 FIG. 4 shows an example of a format of the multiplexed signal passing through the transmission path between the offices. The format shown in FIG. 4 is called a synchronous transport module level 1 (STM-1), and is formed by user information (1.5 Mbps, 2 Mbps) being multiplexed. The STM-1 is constructed with a section over head (SOH) of 9 rows X 9 columns and a payload of 9 rows x 261 columns, where 1 row X 1 column indicates 64 kbps. The user information is carried in the payload. An area of the SOH is used by a network operator. The above-mentioned monitor-and-control information is transmitted on a given channel in the SOH. Therefore, the user information and the monitor-and-control information of the offices are multiplexed, and a multiplexed signal is transmitted through the one communication line.

25 When the network architecture is developed, or when functions of the equipment in the offices are added and changed, new software for the monitor-and-control part needs to be loaded. The software downloading operation may be carried out through the above-discussed given channel in the SOH for transmitting the monitor-and-control information.

30 FIG. 5 shows an example of a frame format of the monitor-and-control information. The frame format shown in FIG. 5 uses a conventional HDLC format. When the software is downloaded, download information is set instead of the monitor-and-control information.

1 Generation of such a frame is carried out by a
dedicated communication processing apparatus (which
may be integrated into an LSI chip).

5 FIG. 6 shows a block diagram of a
configuration example of the monitor-and-control part.
The monitor-and-control parts 15, 25, 35 shown in FIG.
3 have the substantially same configuration. The
configuration of the monitor-and-control part shown in
FIG. 6 is represented in common for the above three
10 monitor-and-control parts shown in FIG. 3. The
monitor-and-control part shown in FIG. 6 includes a
first communication interface part 40 (communication
LSI chip), a second communication interface part 42, a
communication CPU 44, a monitor-and-control register
15 46, a monitor CPU 48, and a common memory part 50.

Trouble of the apparatus in the equipment
and trouble of the communication lines is detected in
the monitor-and-control register 46. This
monitor-and-control register 46 also has a function of
20 controlling the communication apparatuses. The
information from the monitor-and-control register 46
is read in the monitor CPU 48, and is written into the
common memory part 50 which can be accessed also by
the communication CPU 44 to be transferred to the
25 upper-level office. The communication CPU 44 reads
the information written in the common memory part 50,
transfers it to the first communication interface part
40, converts it to a given communication frame format
(shown in FIG. 5), and transmits it to the upper-level
30 office. The above is a sequence of the monitor-and-
control function of the monitor-and-control part.

A function of the communication CPU 44 is
operated by an application program stored in ROM1 and
ROM2. A function of the monitor CPU 48 is operated by
35 an application program stored in ROM3 and ROM4. By
the software downloading operation, the application
programs of the communication CPU 44 and the monitor

1 CPU 48 and the dedicated information for the apparatus
in the office (office information) are changed through
communication lines.

Next, a downloading operation in the network
5 shown in FIG. 3 will be discussed in detail.

First, a download instruction is transmitted
from a terminal device such as work station 18
connected to the terminal-office equipment 10 in the
office A. At this time, the download information to
10 be transmitted has common information for the
equipment in all offices and dedicated information for
the given equipment. In the dedicated information, an
office ID indicating a destination office of the
dedicated information to be transmitted is included.
15 On the other hand, after the common information is
downloaded to all the offices, the dedicated
information may separately be transmitted
(downloaded).

The following description will show a case
20 where the work station 18 in the office A transfers
the download information to the office B, and the
download information received in the office B is
transferred to the office C.

First, the work station 18 in the office A
25 establishes a connection with the second communication
interface part 42 of the monitor-and-control part in
the office to be downloaded (office B, in this case)
through the communication line. In this case, the
work station 18 operates as a server. After the
30 connection with the office B is established, the
download information transmitted from the work station
18 is transferred to the monitor-and-control part 25
in the office B through the communication line.

In the office B, the communication CPU 44 in
35 the monitor-and-control part 25 of the reception side
stores the download information in the ROM area
connected to the bus. For the ROM, a write-enable-

1 type memory such as a flash memory and EEPROM is
usable.

Further, to prevent a normal operation from
being influenced, the ROM is doubled with a regular
5 ROM face and an opposite ROM face. Since the regular
ROM face is currently being used, the downloaded
information is written in the opposite ROM face. On
the other hand, the download information is not
directly transferred to the ROM, but may temporarily
10 be transferred to another memory and may be
transferred to the ROM area of each CPU. The download
operation to the ROM3 and ROM4 of the monitor CPU 48
may be performed by writing the download information
to the common memory part 50 by the communication CPU
15 44, and by writing the download information to the
ROM3 and ROM4 by the monitor CPU 48.

When storage of the download information to
the ROM area is completed, a signal indicating the
completion is transmitted to the work station 18 in
20 the office A.

Next, the monitor-and-control part 25 in the
office B operates as the server, and transfers the
received download information to the monitor-and-
control part 35 in the office C. At this time, a
25 connection for the information transferring is
established between the first communication interface
part 40 in the monitor-and-control part 25 and the
first communication interface part 40 in the monitor-
and-control part 35. After the connection is
30 established, the download from the office B to the
office C is carried out in the same way as that
mentioned above. After storing of the download
information is completed, the signal indicating the
completion is transmitted to the office B of the
35 server. The office B transmits the completion signal
from the office C to the work station 18.

After the office A as a master supervisory

1 office received the completion signals from all the
offices, the office A instructs the offices to change
the regular ROM face currently being used to the
opposite ROM face where the new application program is
5 stored. This instruction information is also
transmitted in the same transferring order as that of
the download information.

The above is a series of sequences for
downloading the information.

10 Next, a description will be given of a first
embodiment of the downloading method according to the
present invention. FIG. 7 shows an illustration for
explaining an operation of the first embodiment of the
downloading method according to the present invention.
15 FIG. 7 shows a case where the downloading method
according to the present invention is applied to a
network model having a plurality of offices A to F
connected in series (linear structure). At an initial
condition, the office A operates as the server.

20 In the downloading method according to the
present invention, the server office downloads data to
an intermediate office of the remaining offices
(undownloaded offices). At the next timing, the
office to which the data has been downloaded operates
25 as the server, and from a plurality of servers, the
download operations are carried out in parallel.

In FIG. 7, the offices A to F are connected
in series. Now, a case where the download is carried
out from the office A to the offices B to F will be
30 discussed. The intermediate office of the offices B
to F is the office D. Therefore, at a first timing
t1, download from the office A to the office D is
carried out. After the download from the office A to
the office D is completed, the office D operates as
35 the server.

At the next stage, download from the office
A to the offices B, C and download from the offices D

1 to the offices E, F needs to be carried out. For the
download, an intermediate office of the offices B, C
and an intermediate office of the offices E, F are
determined. In this case, either of the office B and
5 the office C may be the intermediate office, and
either of the office E and the office F may be the
intermediate office.

Therefore, at a second timing t_2 , for
example, the download from the office A to the office
10 B and the download from the office D to the office E
are simultaneously carried out. After that, the
office B and the office E also may operate as the
servers. At a third timing t_3 , download from the
office B to the office C and download from the office
15 E to the office F are simultaneously carried out.

According to the prior-art downloading
method, in the above-mentioned network model in which
the offices are connected in series, timings t_1 to t_5
are required for the download from the office A to the
20 offices B to F. On the contrary, in the downloading
method according to the present invention, the
download time for the download from the office A to
the offices B to F is the timings t_1 to t_3 .
Therefore, according to the present invention, the
25 download time may positively be approximately $\log_2 n$
times the download time for one office. As a result,
by applying the downloading method according to the
present invention, the download time may be extremely
reduced as compared to the prior-art downloading
30 method.

In the first embodiment, after the
information data is downloaded to the office, the
monitor-and-control part of the office may operate as
the server, and further downloads received information
35 data to another office. Therefore, each monitor-and-
control part needs to store a download plan which
indicates the destination office of the download. The

1 download plan may be stored in the ROM1 and ROM2, or
the RAM1 shown in FIG. 6.

When the network model is initially
determined, the download plan is determined for each
5 office. In the first embodiment, the download plan is
previously determined by a manual method. When the
network architecture is changed by addition of
offices, etc., the download plan is newly determined
by the manual method, and is transferred to each
10 office to be stored in the memory.

After the download to one office is
completed, the communication CPU 44 of the
monitor-and-control part in the office establishes a
connection with a given office based on data stored in
15 the above-mentioned memory, and carries out the
download to the given office.

Next, a description will be given of a
method of determining the above-mentioned download
plan. FIG. 8A and FIG. 8B show illustrations for
20 explaining a downloading order of the downloading
method according to the present invention. FIG. 8A
shows a case where a number of offices to be
downloaded is an odd number, and FIG. 8B shows a case
where a number of offices to be downloaded is an even
25 number.

When the number of the offices to be
downloaded is odd, as shown in FIG. 8A, the
intermediate office may easily be determined to be the
office D. When the number of the offices to be
30 downloaded is even, as shown in FIG. 8B, the
intermediate office may be the office C or the office
D. In this case, even if either of the offices C and
D is determined to be the intermediated office, a total
download time is the same.

35 Next, a description will be given of the
communication LSI circuit (the first communication
interface part shown in FIG. 6) used in the

1 downloading method according to the present invention.
As mentioned before, the download information is
transmitted and received between the communication LSI
circuits of the monitor-and-control parts in the
5 offices. Therefore, though the terminal-office
equipment in the offices A, C shown in FIG. 3
respectively have at least one communication LSI
circuit, the transit-office equipment in the office B
shown in FIG. 3 has a plurality of communication LSI
10 circuits. However, in FIG. 1, when the download from
the office A to the office C is carried out, the
download information is transmitted through the office
B. In this case, in the office B, the download
information is directly transmitted between the
15 multiplex/demultiplex parts without passing through
the communication LSI circuit.

FIG. 9A and FIG. 9B show a method of
establishing the connection in the downloading method
according to the present invention. FIG. 9A shows a
20 configuration of the connection, and FIG. 9B shows a
control sequence. When the download information is
transferred from the office A to the office C, the
office A produces a through-control instruction to the
office B. In the office B, in response to the
25 through-control instruction, a through line in the
signal transmission part without passing through the
LSI circuit. In this way, the connection is
established between the communication LSI circuit in
the office A and the communication LSI circuit in the
30 office C, and the download information is transferred
through this connection.

FIG. 9C and FIG. 9D show another method of
establishing the connection in the downloading method
according to the present invention. FIG. 9C shows a
35 configuration of the connection, and FIG. 9D shows a
control sequence. The method in FIG. 9C shows a case
where the information is transferred from the office A

1 to the office C through a communication LSI circuit
individually provided in the transit office B.

When equipment in the offices is started up,
each link between two offices adjacent to each other
5 is established, the offices are prepared to transfer
the information by the respective offices'
communication LSI circuits (communication connection
establishment condition). At this time, between the
two offices adjacent to each other, the information
10 shown in FIG. 5 is transmitted and received.

In the information, in addition to the
information (the download information) to be
transferred to each office, destination information
indicating a destination office of information
15 transference is also included.

In the transit office B positioned between
the server office (office A) and the destination
office (office C), once the download information is
received, the download information is determined to be
20 one for the office C based on the destination
information. Therefore, the download information is
directly transferred to the office C.

In the same way, the data reception response
is transmitted from the office C to the office A
25 through the communication LSI circuit in the office B.
Such communication is commonly called a packet
communication. The method of transferring the
information through the transit office is not limited
to the above-discussed configuration example, but is
30 operable in other configuration examples.

FIG. 10 shows a detail configuration of the
through line in the transit-office equipment. In FIG.
10, to simplify the description, only the
multiplex/demultiplex parts (MUXs) and the
35 communication LSI circuits of the monitor-and-control
part in the transit-office equipment are shown.

In the transit-office equipment, the through

1 line is established between the multiplex/demultiplex
parts. When the through line is established, only the
download information in a control channel is
transmitted through the through line without being
5 dropped into the communication LSI circuits. The
through line may be formed by switches such as relays.
The switches may select whether passing the download
information or dropping the download information into
the communication LSI circuit and transmitting to the
10 other office.

Next, a description will be given of a
second embodiment of the downloading method according
to the present invention. In the first embodiment of
the downloading method, the destination offices of the
15 download, namely the download plan, needs to manually
be determined. Therefore, in this method, whenever
the network architecture is changed, the download plan
needs to be calculated for each office.

In the second embodiment of the downloading
20 method, the download plan of each office is
automatically calculated in that office. Therefore,
information of the network architecture, namely,
topology information in the network, is previously
informed to each office. In the present invention,
25 the second embodiment of the downloading method in
which the download plan is calculated in each office
is called a recursive-processing-type downloading
method.

FIG. 11 shows a memory configuration storing
30 the topology information of the network shown in FIG.
7. Each office has the topology information, and
determines the destination office of the download
based on the topology information. Each office knows
a rule that a downloading order is shown as from a
35 lowest-address-number (in this case, address 1) office
in the memory to a higher-address-number office.

Further, when download is carried out to the

1 intermediate office, the offices of the network are
virtually divided into two groups, each group includes
the office having the download information (the server
office). When the next download is completed, each of
5 the two groups are further divided into two groups.
In this way, in the downloading method according to
the present invention, a number of the server offices
increases in a manner of a factorial of 2. Since the
downloading operations are carried out in parallel by
10 these server offices, the total download time may be
reduced.

In this case, each office needs to always
know temporal topology information which the offices
of the network are virtually divided. Based on the
15 temporal topology information, the next destination
office of the download is determined. The temporal
topology information is calculated by the following
download algorithm, and is always stored in the RAM.

FIG. 12 shows a flowchart of the download
20 algorithm which is provided in each office. FIG. 13
shows an illustration for explaining a downloading
operation of the recursive-processing-type downloading
method based on the algorithm shown in FIG. 12. FIG.
14 shows a flowchart of the downloading operation in
25 each office.

According to the download algorithm shown in
FIG. 12, each office, at a given timing, calculates a
server-office number of the network topology, the
destination-office number (intermediate office), and a
30 maximum number of offices. FIG. 13 shows the
downloading operation in the offices A to F connected
in series with the temporal topology information which
is calculated by the algorithm shown in FIG. 12. Each
office carries out the algorithm shown in FIG. 12 for
35 each download timing, and calculates the temporal
topology information at that timing.

Next, according to the flowchart shown in

1 FIG. 14, based on the temporal topology information,
the office carries out reception of the download
information, transmission of the download information,
establishment of the through line, and a completion
5 operation. In the following, by referring to the FIG.
13, an operational sequence of the recursive-
processing-type downloading method is discussed.

At a timing t_0 before the download, each
office has the topology information shown in FIG. 11.
10 First, the topology information is written such that
the server-office number = 1, the destination-office
number = 4, and the maximum number of the offices = 7.
At the next timing t_1 , the first download is carried
out. At this time, each office can know that the
15 download information is downloaded to the office D at
the timing t_1 based on the topology information at the
timing t_0 .

Further, at the timing t_1 , according to the
download algorithm, the topology information at the
20 timing t_0 is virtually divided into two temporal
topology information, first temporal topology
information being constructed with the offices A to C
including the server office A, and second temporal
topology information being constructed with the
25 offices D to F including the server office D. Each
office has corresponding temporal topology
information.

Therefore, at the next timing t_2 , in each
office, based on the temporal topology information,
30 the download algorithm is carried out, and the next
destination office is determined. Shadowed parts
shown in FIG. 11 indicate the destination offices of
the download in each office.

At the timing t_2 , the topology information
35 constructed with the offices A to C is divided into
the office A and the offices B, C. In the same way,
the topology information constructed with the offices

1 D to F is divided into the office D and the offices E,
F.

At the next timing t3, the topology
information constructed with the offices B, C is
5 divided into the office B and the office C. In the
same way, the topology information constructed with
the offices E, F is divided into the office E and the
office F. At last, when the topology information
having the offices A to C is divided into 6 topology
10 information, each of which having an individual
office, all the offices may have the download
information.

In the flowchart shown in FIG. 12, when the
number of the offices is even, the algorithm is
15 designed such that the download is carried out to the
office closer to the server office. However, the
download may be carried out to the office farther from
the server office. This method may be performed by
changing an equation for calculating the intermediate
20 office to the following equation.

Destination-office number =
((server-office number +
maximum number of offices) / 2) + 1
25 where a decimal is counted to round off the number.

As mentioned above, in the second
embodiment, when the network architecture is changed,
each office may easily obtain the information in
30 relation to the next destination office for the
download by an individual office's calculation.
Therefore, even if the network architecture is
changed, only by transferring the topology information
of the initial network architecture to each office,
35 the downloading operation may be easily carried out.

Next, a description will be given of a third
embodiment of the downloading method according to the

1 present invention. FIG. 15 shows a flowchart of a
transmitting-and-receiving parallel process in the
third embodiment of the downloading method according
to the present invention. In the first and second
5 embodiments, the method of downloading one download
information to all offices is shown. Therefore, only
after the office completely received the downloaded
information, the office can transfer the downloaded
information to another office.

10 In the third embodiment, the download
information is divided into a plurality of blocks, and
the blocks are downloaded in parallel. Every time
each office receives one block, the office transfers
the block to the next office. In this case, with
15 receiving a first block, the office can transfer a
second block. Namely, in each office, the receiving
process and the transmitting process may be carried
out in parallel. In the above-mentioned method, since
an error control, etc., are carried out at any time,
20 communication processing equipment for two lines are
required.

According to the third embodiment, the
download information is divided into the plurality of
blocks, and for each block, the transmitting process
25 and the receiving process are carried out in parallel.
Therefore, the download time may be further reduced as
compared to the previously mentioned two embodiments.

Next, a description will be given of a
fourth embodiment of the downloading method according
to the present invention. The fourth embodiment is
30 given by adding a completing process sequence to
either of the above three embodiments.

In any downloading method, to confirm
whether the download information is regularly
35 transferred to all offices, each office needs to
return a response indicating regular completion to the
server office. However, when all offices return a

1 plurality of responses to the server office at random,
traffic overlapping in the transmission path and
collision between the responses occur. For example,
in the network model shown in FIG. 7, when the
5 download from the office A to the office B and the
download from the office D to the office E are carried
out at the timing t_2 , if the offices B and E
simultaneously return the responses to the offices A
and D, respectively, a traffic overlapping in the
10 transmission path occurs between the office A and the
office B. Whereby, efficiency of the downloading
operation is degraded.

FIG. 16 shows an illustration of explaining
a responding method in the downloading method
15 according to the present invention. In this
responding method, when the download information is
downloaded to the office, the office immediately
returns the regular completion response to the server
office through the connection established for the
20 downloading operation. An office which received the
completion response receives all responses from
associated offices. When the office receives all the
responses, the office transmits response information
having all the responses from the associated offices
25 to the server office of itself. If no response from
the associated offices is returned to the office,
information of no response from the associated offices
is also transferred to the server office. In this
way, without degrading the efficiency of the
30 downloading operation, the response of the regular
completion may be returned.

In the above-mentioned four embodiments, the
initial destination office for the downloading
operation is set to the intermediate office between
35 the offices to be downloaded. In this way, by
downloading to the intermediate office, the most
efficient downloading operation may be realized.

1 However, the downloading method according to the
present invention is not limited to the above case
where the download is carried out to the precisely-
calculated intermediate office. Another case where
5 the download is carried out to the substantially-
intermediate office is also included in the scope of
the present invention.

 In the above-discussed embodiments, the
downloading method according to the present invention
10 has been described for the network in which the
plurality of offices are connected in series.
However, a practical network commonly has a complex
configuration.

 FIG. 17 shows a configuration example of a
15 typical main transmission network. The main
transmission network shown in FIG. 17 is constructed
with offices A to N. In the network, the offices A to
E, and the offices F to L are formed respectively in
ring forms. The offices M, N forms a branch from the
20 office D. In such a complex network, all the offices
are not connected in series. Therefore, the present
invention may not directly be applied to all the
offices in the network. However, any complex network
may be virtually analyzed into a network which is
25 constructed with a plurality of offices connected in
series (linear structure). Therefore, by virtually
analyzing the network into a plurality of serially-
connected offices, the present invention is applicable
to that complex network.

30 FIG. 18A and FIG. 18B show examples of the
method of virtually analyzing the complex network
shown in FIG. 17. In these networks shown in FIG. 18A
and FIG. 18B, each network has a plurality of
branches. Each branch further include a plurality of
35 offices connected in series.

 In FIG. 18A, the offices A to C are
connected in series, and the offices A to J are

1 connected in series. In the same way, the offices E
to N, and the offices F to I are respectively
connected in series.

5 In FIG. 18B, the offices A to N are
connected in series, and the offices D to L are
connected in series. The present invention is
applicable to each of the serially-connected offices.
Therefore, the downloading method according to the
present invention is applicable to any complex
10 network.

Further, the present invention is not
limited to these embodiments, but other variations and
modifications may be made without departing from the
scope of the present invention.

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WHAT WE CLAIM

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1. A method of transferring information to a plurality of offices connected in series in a network, said method comprising the steps of:

10 (a) transferring said information from a server office to an intermediate office being substantially intermediate in said plurality of offices;

15 (b) setting the intermediate office which received said information in the step (a) to said server office;

(c) virtually dividing said plurality of offices into two groups which respectively include said server offices; and

20 (d) repeating said steps (a) to (c) for each of said two groups.

25

2. The method as claimed in claim 1, wherein said method further comprises a step of previously storing in a memory which office in said plurality of offices is said intermediate office.

30

3. The method as claimed in claim 1, wherein said step (a) further comprises a step of calculating which office in said plurality of offices is said intermediate office based on a network architecture.

1 4. The method as claimed in claim 1, wherein
said method further comprises a step of dividing said
information into a plurality of blocks, and every time
one block of said blocks is received in each office,
5 transmitting said one block to a next office.

10 5. The method as claimed in claim 1, wherein
said method further comprises the steps of:

 returning a response indicating a regular
completion of receiving said information from a first
office which received said information to a second
15 office which transferred said information to said
first office; and

 receiving a plurality of said responses in a
third office from other offices following the third
office, and returning said plurality of responses from
20 the third office to a fourth office which previously
transferred said information to the third office.

25 6. The method as claimed in claim 1, wherein
said step (a) comprises a step of downloading software
to said intermediate office.

30

 7. An apparatus for transferring information
from a server office to a plurality of offices
35 connected in series in a network, said apparatus
comprising:

 receiving means for receiving said

1 information;

transferring means for transferring said
information to an intermediate office being
substantially intermediate in said plurality of
5 offices.

10 8. The apparatus as claimed in claim 7,
wherein said apparatus further comprises a memory
storing which office in said plurality offices is said
intermediate office.

15

9. The apparatus as claimed in claim 7,
wherein said apparatus further comprises calculating
20 means for determining which office in said plurality
offices is said intermediate office based on a network
architecture.

25

10. The apparatus as claimed in claim 7,
wherein said apparatus further comprises parallel-
process control means for dividing said information
30 into a plurality of blocks, and transmitting one block
of said blocks to a next office every time said one
block is received.

35

11. The apparatus as claimed in claim 7,

1 wherein said apparatus further comprises:

first responding means for returning a
response indicating a regular completion of receiving
said information to an office which transferred said
5 information to said apparatus; and

second responding means for receiving a
plurality of said responses from other offices and for
returning said plurality of responses to an office
which previously transferred said information to said
10 apparatus.

15 12. The apparatus as claimed in claim 7,
wherein said transferring means comprises means for
downloading software to said intermediate office.

20

13. A method of transferring information
substantially as hereinbefore described with reference
to and as illustrated in FIG. 3 through FIG. 18B of
25 the accompanying drawings.

30 14. An apparatus of transferring information
substantially as hereinbefore described with reference
to and as illustrated in FIG. 3 through FIG. 18B of
the accompanying drawings.

35



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Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): G4A (AFGK); H4P (PPBB, PPBC, PPD, PQA)

Int Cl (Ed.6): H04L 12/407, 12/42, 12/44; H04Q 3/00

Other: Online:WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
X	GB2173977A (STC) Whole document, eg Figs. 1 and 8	1-3,7-9 at least
XP	EP0689325A2 (AT&T GIS) Whole document, eg page 5 lines 10-44.	1-3,6-9,11,12 at least
X	EP0234618A1 (Philips) Whole document, eg, Figs 1b-5	7-9 at least
X	WO87/02155A1 (Schlumberger) Whole document, eg Figs 1,5,6,9	7-9 at least
X	US5005122 (Digital Equipment) Whole document, eg Fig. 1 and cols. 4-6	1-3,6-9,12 at least

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
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